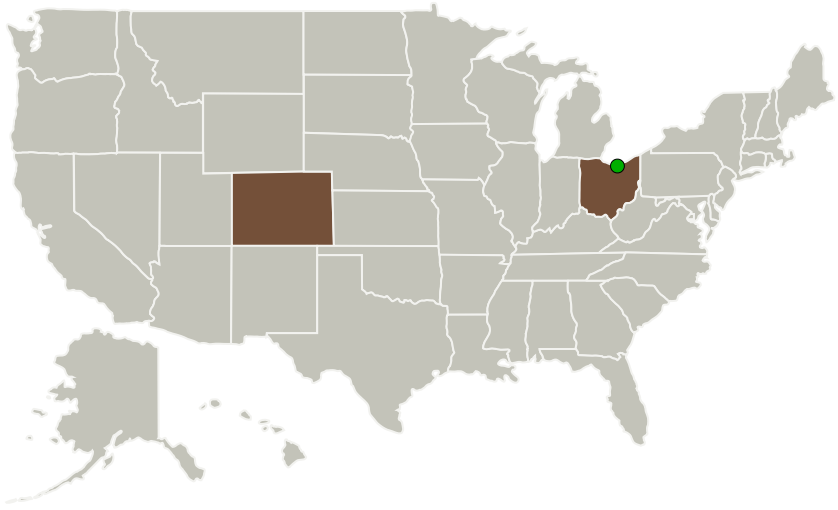
LMM Holographic Optical Tweezers (HOT) Module, Phase I

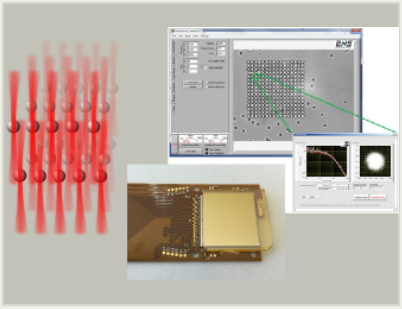
Completed Technology Project (2015 - 2015)

Project Introduction

We propose to expand the capabilities of the LMM for colloidal and other research by developing a holographic optical tweezers (HOT) module, allowing solid-state software-controlled micromanipulation with no moving parts. A HOT device produces hundreds of independently-steerable and independently-focusable beams, as well as other arbitrarily-complex 3D illumination patterns. HOT is useful for colloidal research, with the ability to precisely position collections of particles within colloids, and to use optically-trapped particles to measure linear and nonlinear viscoelastic properties of fluids. Each HOT beam can be a traditional trapping beam, or can impart rotational angular momentum to particles via Bessel beam profiles. HOT systems are also used in biological research, for example in measuring the mobility and deformability of cells (a measure of cellular health, and an indicator of damage), and in rotating or sorting individual cells. All of these capabilities are possible using the same hardware, with beam configuration, power, and motion controlled entirely by software and voltage applied to a motionless solid-state device. Due to its built-in adaptive optics capability, a HOT system can also diagnose and correct for its own alignment errors. The ability to remotely add, upgrade, or repair capabilities via software alone makes holographic micromanipulation a core capability for ISS research. BNS proposes to develop a HOT module for the LMM, capitalizing on our previous experience in developing a commercially-available standalone HOT microscope, our current efforts toward developing a multibeam holographic photostimulation module for commercial microscopes, and on our widely-used, flight-tested spatial light modulators (SLMs).

Primary U.S. Work Locations and Key Partners





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Organizations Performing Work	Role	Type	Location
Boulder Nonlinear Systems, Inc.	Lead Organization	Industry	Lafayette, Colorado
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Colorado	Ohio

Project Transitions

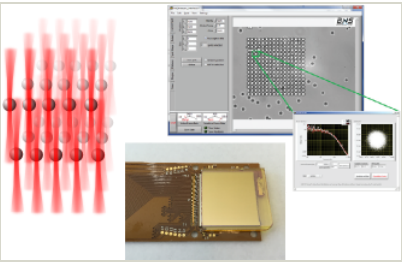
June 2015: Project Start

December 2015: Closed out

Closeout Summary: LMM Holographic Optical Tweezers (HOT) Module, Phase I Project Image

Closeout Documentation:
- Final Summary Chart Image*(https://techport.nasa.gov/file/139160)*

Images



Briefing Chart Image
LMM Holographic Optical Tweezers (HOT) Module, Phase I
(https://techport.nasa.gov/image/127939)

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
Boulder Nonlinear Systems, Inc.

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

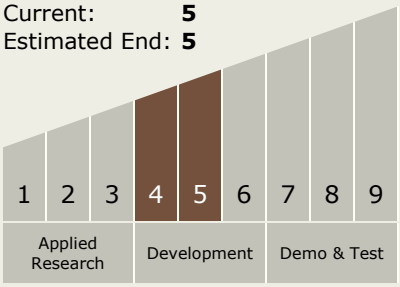
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Steve Serati

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**



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Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.3 Optical Components

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System